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Diversity of angiospermic plants in Dhanaulti Region, Uttarakhand: an emerging tourist destination in Western Himalaya

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Abstract: Situated adjacent to Mussoorie, the popular hill station in Uttarakhand state of India, Dhanaulti region is known for its scenic environs amidst the temperate forests. The floristic survey revealed a total of 112 species belonging to 96 genera and 47 families. Poaceae was the largest family with 16 genera and 17 species followed by Rosaceae represented by nine genera and 13 species and Asteraceae with eight genera and eight species. Lamiaceae and Caprifoliaceae had four species each while Brassicaceae, Celastraceae, Cyperaceae, Fabaceae, Orchidaceae, Plantaginaceae and Smilacaceae had three species each. Most dominant genus was *Rubus* with four species followed by *Euonymus* and *Smilax* with three species each. Two vulnerable species, *Bergenia ciliata* (Haw.) Sternb. and *Valeriana jatamansi* Jones, were also recorded. This study in addition gives an account on ethnobotanical uses of 51 species. Since Dhanaulti is an emerging tourist destination in Western Himalaya, the study will generate baseline information for management authorities to give due importance to its ecological wealth while planning any development in future.

Key words: Garhwal Himalaya, Mussoorie, eco-parks, threatened taxa

INTRODUCTION

Indian Himalayan Region, known for its rich biodiversity, supports about 18,440 plant species, i.e., 8,000 angiosperms, 44 gymnosperms, 600 pteridophytes, 1,737 bryophytes, 1,159 lichens and 6,900 fungi (Singh and Hajra 1996) and over 1,748 medicinal plants (Samant et al. 1998). The Western Himalaya (WH), wherein Garhwal Himalaya lies, has been identified as a major hotspot of endemic and genetic diversity in India (Rao 1994). Uttarakhand in the WH is rich in biological diversity due to its deeply dissected topography, complex geological structure, wide elevational range and varied climatic conditions. The state is divided into two regions, Garhwal and Kumaon.

The Garhwal Himalaya (GH), in the western part of Uttarakhand state, forms transition zone between three different floristic provinces: Tibetan province in the North, Upper Gangetic Plain province in the South and Central Himalayan province in the East. The GH has more than 3,500 species of flowering plants most of which are in temperate forests and alpine meadows. Thirty species listed in the "Indian Red Data Book" (Nayar and Sastry 1987, 1988, 1990) have been found to be distributed in Garhwal Himalaya. Several taxonomic studies have been undertaken in this region; viz., Duthie (1922) made an account of the Flora of Upper Gangetic Plain and of the adjacent Siwalik and Sub-Himalayan Tracts. Stewart (1942) worked on the ferns of Mussoorie and Dehradun, reporting 112 species. Raizada and Saxena (1978) worked in and around Mussoorie and reported over 1,331 species. Polunin and Stainton (1984) reported 1,495 species of flowering plants from Western Himalayas spread across India and Nepal. Stainton (1988) published supplement to this work adding 584 species. The floristic diversity of the Binog Wildlife Sanctuary adjacent to Mussoorie and Dhanaulti region reported 335 species belonging to 237 genera under 102 families (Kumar et al. 2012). In India, the importance of floristic assessment in protected areas has been recognized widely, albeit equally important is to explore the currently little known microhabitats of Forest Divisions (FD; covering forest blocks and compartments) which represent the management unit in the hierarchy of forest departments in the country.

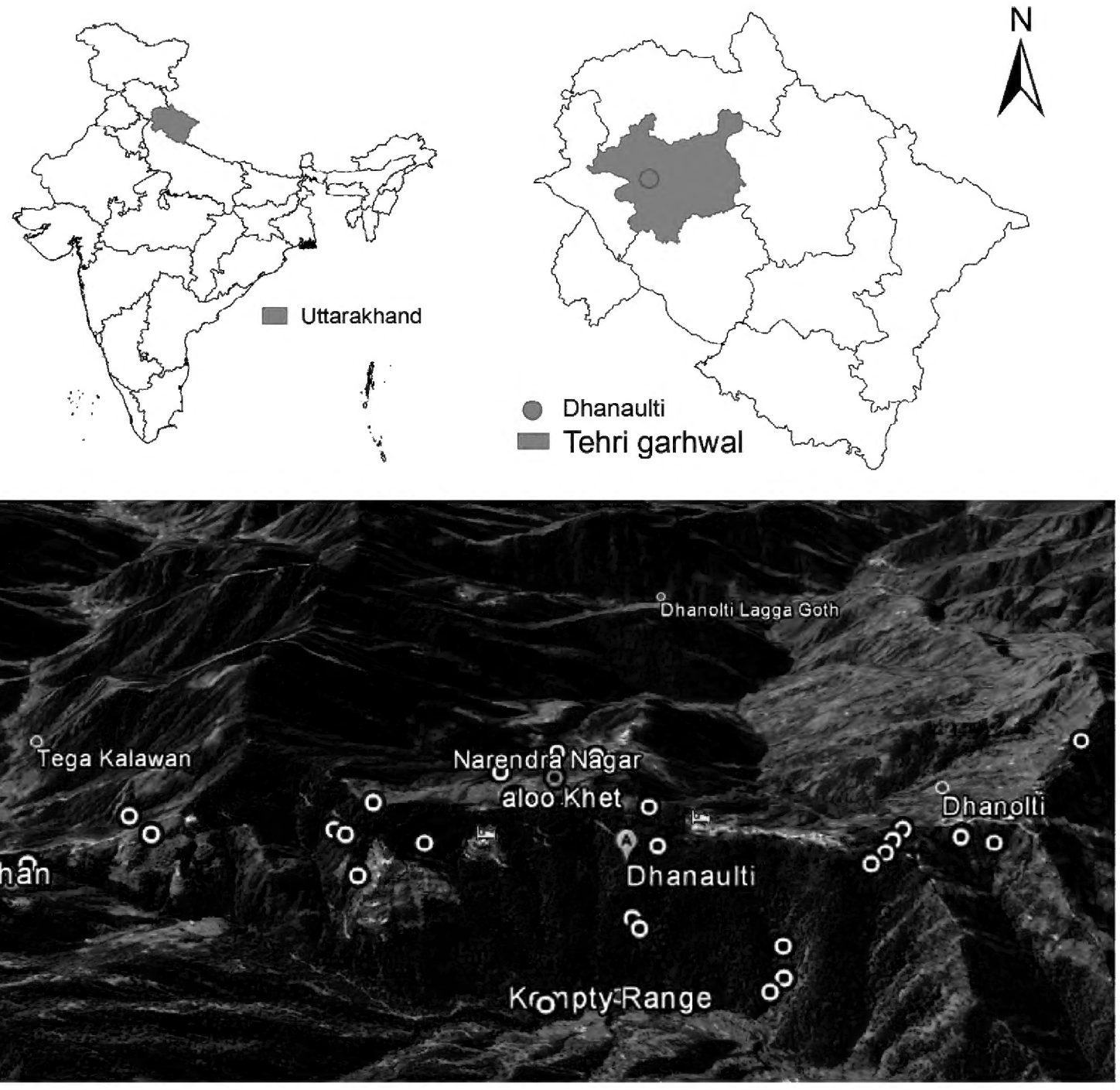

Figure 1. Map showing location of the study area.

Moreover, studies pertaining to understand the plant diversity in flowering or fruiting stage of a particular season or period have a greater role while understanding the phenology of the plant species. Hence, keeping this in view the need was felt and an attempt has been made to document the plant species of Dhanaulti region of Mussoorie forest division, which came into limelight after the establishment of the Dhanaulti Eco-Park. The study also gives an account of the ethnobotanical uses of plant species of the region. As an emerging tourist destination, the region is certain to undergo cycles of development and might face human encroachments and threats due to mismanagement. Thus, this study presents a baseline for future monitoring studies and development planning by forest managers, conservationists, ethnobotanists and researchers.

MATERIALS AND METHODS

Study area

Dhanaulti, a hill station situated close to the popular hill station of Mussoorie also known as *'Queen of hills'*, is known for its quiet environs amidst the temperate forests. It lies in the western part of the Uttarakhand state in India at 30°42′ N, 078°24′ E at an elevational range of 2,118–2,415 m (Figure 1). The study area includes Dhanaulti forest block (328 ha) covering twin eco-parks, "Amber" and "Dhara", within the Mussoorie Forest Division. The region gained popularity due to the immense scenic beauty adhered with tourism perspectives that led to the opening of eco-parks. The parks, also known as the Dhanaulti Eco-Parks, were set up by the Uttarakhand Forest Department with the help of local youth in 2008. These parks, spread over an area of 13 ha, were set up with an aim to mitigate pressure on forest ecosystem by providing employment to the local people through their participation in the management of forest. Over 50 locals including both male and females are employed as service and information providers such as guides, gardeners, ticket collectors, etc. A handicraft shop has been set up that sells local handicrafts, hand woven woollen garments, packaged organic food items, etc. Topography of the region is mountainous with major soil type being loamy-clay. The Dyuligaad River, flowing down the valley, is the main source of water. The area is broadly characterized by Himalayan moist temperate forest (Champion and Seth 1968) comprising of pure stands of *Cedrus deodara* (Roxb. ex D.Don) G.Don and Rhododendron-Oak (*Rhododendron arboreum* Sm. and *Quercus leucotrichophora* A. Camus) mixed forests. The lower reaches have pure Chirpine (*Pinus roxburghii*

Sarg.) forests. A people participatory committee, Dhanaulti Ecology and Ecotourism Development Committee (DEEDC), looks after the management of parks. The number of tourists flocking to the park has substantially increased from 43,281 in 2008 to 1,19,745 in 2012. Despite this, the well designed mandate of this eco-park has led to improvement of ecosystem and environmental conditions of Dhanaulti through the approach of participatory conservation (Kala 2013).

Data collection

The present work is a result of detailed and careful survey of the area in and around Dhanaulti forest block for angiospermic plants. A reconnaissance survey was carried out in February 2014. This was followed by extensive field surveys every week in order to cover all the forest types, viz., a) Deodar Forest, b) Rhododendron-Oak Mixed Forest and c) Grassland, during late winter, spring and summer seasons of 2014. The floristic surveys and specimen collections were carried out on foot along the existing trails, water streams (*nallahs*) and various habitats in and around forests, grasslands and human habitations. During collection, detailed field observations were recorded, including notes on ethnobotanical uses of various plants by the local people. The plants were collected, identified and herbarium sheets were prepared following standard methods (Jain and Rao 1977). Identification of plant species was done using existing literature (Gaur 1999; Polunin and Stainton 1984; Raizada and Saxena 1978; Lawrence 1964) and with the help of taxonomists at the National Botanical Research Institute, Lucknow and the Wildlife Institute of India, Dehradun. Identification was cross-checked by comparing voucher specimens with the standard specimens in herbaria of CSIR-National Botanical Research Institute, Lucknow (LWG), Botanical Survey of India, Dehradun (BSD) and Indian Council of Forestry Research and Education, Dehradun (DD). The collected plants were dried, pressed and mounted on herbarium sheets and thereafter deposited at the CSIR-National Botanical Research Institute herbarium (LWG). For updated botanical names, authorities, genera and families of plant species, www.theplantlist.org website has been used. Ethnobotanical surveys were conducted with *Garhwali* communities from the area and the information on vernacular names of plants, plant part used and uses was gathered.

RESULTS

Floristic diversity

The study revealed a total of 112 species of angiospermic plants belonging to 96 genera and 47 families. For each of the species, the current valid name and author citation along with its vernacular name, habit, habitat, voucher specimen number and ethnobotanical notes have been provided in Table 1. Poaceae was the dominant family (16 genera and 17 species) followed by Rosaceae (9 genera and 13 species; Figure 2).

The dominant genus was *Rubus* with four species namely *Rubus ellipticus* Sm., *R. macilentus* Cambess, *R. foliolosus* D.Don and *R. niveus* Thunb. followed by *Euonymus* and *Smilax* with three species each.

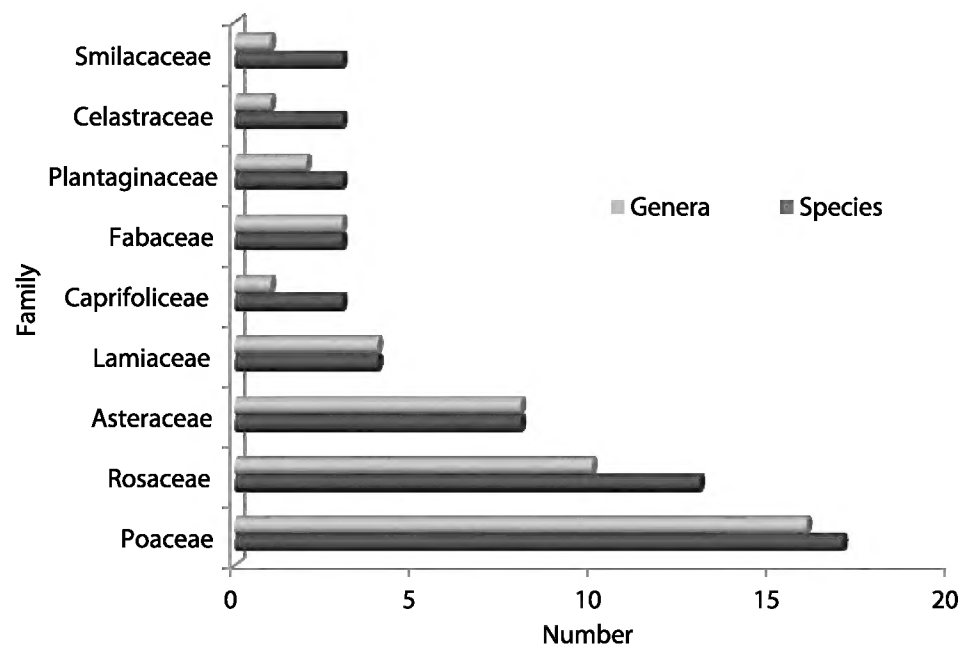

Figure 2. Dominant families with their respective number of genera and species in Dhanaulti region, Uttarakhand.

Table 1. Plant species of Dhanaulti region, Uttarakhand with their family, vernacular name, habit, habitat, voucher specimen number and ethnobotanical uses. Abbreviations: RS- Roadside, DF-Deodar Forest, ROMF-Rhododendron Oak Mixed Forest, GS-Grassland and HH-Human Habitation.

Family & Species	Vernacular Name	Habit	Habitat	Voucher No.	Ethnobotanical notes
Apiaceae					
Apium leptophyllum (Pers.) F. Muell. ex. Benth.	Kurmura	Herb	RS	LWG 261085	-
Chaerophyllum reflexum Aitch.	-	Herb	RS	LWG 261068	-
Aquifoliaceae					
Ilex dipyrena Wall.	Kandara	Tree	DF, ROMF	LWG 261019	-
Araliaceae					
Hedera nepalensis K. Koch	Mithiari	Climber	DF	LWG 261026	Leaves are used for fomentation in glandular enlargement. Infusion of the berries is used in rheumatism
Asteraceae					
Achillea millefolium L.	-	Herb	HH	LWG 260202	-
Ainsliaea latifolia (D. Don.) Sch.Bip	-	Herb	DF	LWG 261041	-
Erigeron karvinskianus DC.	-	Herb	RS	LWG 261003	-

Continued

Table 1. *Continued.*

Family & Species	Vernacular Name	Habit	Habitat	Voucher No.	Ethnobotanical notes
Gerbera gossypina (Royle) Beauverd	-	Herb	RS	LWG 261099	-
Leucanthemum vulgare (Vaill.) Lam.	-	Herb	RS	LWG 261091	-
Sonchus oleraceus (L.) L.	-	Herb	HH	LWG 261086	-
Taraxacum officinale (L.) Weber ex F.H.Wigg.	Dudhiya, Doodh-feni	Herb	RS	LWG 261020	Roots are used as a diuretic and in complaints of the liver, kidneys and digestive organs. Plant is fed to cattle to increase milk yield.
Youngia japonica (L.) DC.	-	Herb	RS	LWG 261062	-
Berberidaceae					
Berberis chitria Buch.-Ham. ex Lindl.	Kingora	Shrub	RS	LWG 261098	Roots are used to cure jaundice, intestinal problems and eyes diseases.
Berberis lycium Royle	Kingora	Shrub	RS	LWG 261079	
Brassicaceae					
Brassica juncea (L.) Czern.	Laya	Herb	HH	LWG 261074	Seeds yield cooking oil. Paste of roasted seeds is applied on head in alopecia while seed powder given as an emetic.
Capsella bursa-pastoris (L.) Medik.	-	Herb	HH	LWG 261024	Plant paste is applied on cuts and wounds to check bleeding.
Cardamine impatiens L.	-	Herb	HH	LWG 261003	Plant juice is given in fever.
Buxaceae					
Sarcococca saligna Muell.-Arg.	-	Shrub	DF	LWG 261007	Stem is used to make brooms.
Campanulaceae					
Campanula pallida Wall.	-	Herb	HH, RS	LWG 261080	-
Caprifoliaceae					
Leycesteria formosa Wall.	-	Shrub	RS	LWG 260203	-
Lonicera quinquelocularis Hard.	-	Shrub	RS	LWG 261098	Plant is used as fodder and fuel-wood.
Viburnum cotinifolium D. Don	Bhatnai	Shrub	ROMF	LWG 261056	-
Viburnum mullaha Buch.-Ham. ex D.Don	Rindasi	Tree	ROMF	LWG 261075	-
Caryophyllaceae					
Stellaria media (L.) Vill.	Badiyala	Herb	RS, HH	LWG 261015	-
Celastraceae					
Euonymus echinatus Wall.	-	Shrub	RS	LWG 260204	-
Euonymus fimbriatus Wall.	-	Tree	RS	LWG 260205	-
Euonymus tingens Wall.	Bhameli	Shrub	RS	LWG 260201	Plant is a gastro-intestinal stimulant and increases the flow of bile and other secretions. The bark is used in eye diseases.
Commelinaceae					
Commelina benghalensis L.		Herb	GS, ROMF	LWG 260223	
Coriariaceae					
Coriaria nepalensis Wall.	Mansur	Shrub	RS	LWG 260201	Leaves are used as a purgative.
Crassulaceae					
Rosularia rosulata (Edgew.) H. Ohba	Paadi	Herb	RS (Moist, shady places)	LWG 261100	-
Cyperaceae					
Carex setigera D.Don.		Herb	GS	LWG 262234	Plant is used as fodder.
Cyperus rotundus L.		Herb	GS, ROMF	LWG 262210	Plant is used as fodder.
Eriophorum comosum (Wall.) Nees		Herb	GS	LWG 262218	Plant is used as fodder.
Dioscoreaceae					
Dioscorea belophylla (Prain) Voigt ex Haines		Climber	ROMF	LWG 260215	
Ericaceae					
Lyonia ovalifolia (Wall.) Drude	Anyaar	Tree	DF, ROMF	LWG 261071	Leaves are used in skin diseases.
Rhododendron arboreum Sm.	Burans	Tree	ROMF, DF	LWG 261012	Juice of flowers is energetic and blood purifier; wood is used for fuel.
Fabaceae					
Indigofera heterantha Wall. ex Brandis	Kathlu	Shrub	RS	LWG 261096	Plant is used as fodder.
Trifolium repens L.	-	Herb	RS, HH	LWG 261014	-
Vicia hirsuta (L.) Gray.	-	Herb	RS, HH	LWG 261059	-
Fagaceae					
Quercus floribunda Lindl. ex A. Camus	Moru	Tree	DF, ROMF	LWG 261060	Plant is very important source of fodder and fuel.
Quercus leucotrichophora A. Camus	Banj	Tree	DF, ROMF	LWG 261061	Plant is very important source of fodder and fuel.
Gentianaceae					
Gentiana argentea (Royle ex D.Don) Royle ex D.Don	-	Herb	RS, HH	LWG 261031	-

Continued

Table 1. *Continued.*

Family & Species	Vernacular Name	Habit	Habitat	Voucher No.	Ethnobotanical notes
Gentiana capitata Buch.-Ham. ex. D. Don	-	Herb	ROMF	LWG 261017	-
Geraniaceae					
Geranium nepalense Sweet	-	Herb	RS	LWG 260207	Used to treat renal troubles
Geranium rotundifolium L.	-	Herb	RS	LWG 261030	-
Hydrangaceae					
Deutzia staminea R. Br. ex Wall.	Angaari	Shrub	RS	LWG 261084	Plant is used as fodder.
Hypericaceae					
Hypericum oblongifolium Choisy	Patyoli	Shrub	RS	LWG 261093	-
Hypoxidaceae					
Curculigo orchioides Gaertn.		Herb	ROMF	LWG 260220	
Juglandaceae					
Juglans regia L.	Oontis	Tree	HH	LWG 260208	Tree produces edible fruit called walnut.
Lamiaceae					
Clinopodium umbrosum (M. Bieb.) Kuntze	-	Herb	HH, RS	LWG 261053	-
Micromeria biflora (Buch.Ham. ex D. Don) Benth.	-	Herb	HH, RS	LWG 261058	-
Salvia lanata Roxb.	Budli	Herb	RS	LWG 261050	Plant is considered good for health and vigour; flower paste is used in cough and cold. Leaves are used in colic and diarrhoea.
Scutellaria scandens Buch.-Ham. ex D. Don	Mugriya	Herb	RS	LWG 261095	-
Lauraceae					
Dodecadenia grandiflora Nees	Kaul	Tree	ROMF	LWG 26104	-
Neolitsea pallens (D. Don.) Momiy.& H. Hara	Ratnaul	Tree	ROMF	LWG 261003	-
Liliaceae					
Asparagus racemosus Willd.		Climber	ROMF	LWG 262242	
Malvaceae					
Malva parviflora L.	Bheemaldi	Herb	RS, HH	LWG 261046	-
Oleaceae					
Jasminum humile L.	Jayi	Shrub	RS	LWG 261094	Juice of Leaves is used to soften corn between toes. Oil from the leaf is used in skin diseases.
Onagraceae					
Oenothera rosea L'Her. ex Aiton	-	Herb	HH	LWG 261049	-
Orchidaceae					
Calanthe plantaginea Lindl.		Herb	ROMF	LWG 260243	
Cephalanthera longifolia (L.) Fritsch	-	Herb	DF	LWG 261081	-
Zeuxine flava (Wall. ex Lindl.) Trimen		Herb	ROMF	LWG 260227	
Oxalidaceae					
Oxalis corniculata L.	-	Herb	HH	LWG 261022	Whole plant is used in dysentery, diarrhoea and fever. Fresh leaves, in the form of a poultice, are applied on inflamed parts.
Plantaginaceae					
Plantago major L.	-	Herb	HH	LWG 261029	-
Plantago lanceolata L.	-	Herb	HH	LWG 261087	-
Veronica persica Poir.	-	Herb	RS,HH	LWG 261005	-
Poaceae					
Arundinaria falcata Nees.		Herb	GS	LWG 260244	Plant is used as fodder.
Arundinella nepalensis Trin.		Herb	GS	LWG 260224	Plant is used as fodder.
Arundinella pumila (Hochst.) Steud.		Herb	GS	LWG 262239	Plant is used as fodder.
Apluda mutica L.		Herb	GS	LWG 260216	Plant is used as fodder.
Cynodon dactylon (L.) Pers.		Herb	GS	LWG 260240	Plant is used as fodder.
Eragrostis viscosa (Retz.) Trin.		Herb	GS	LWG 260236	Plant is used as fodder.
Erianthus rufipilus Griseb.		Herb	GS	LWG 260229	Plant is used as fodder.
Heteropogon contortus (L.) P. Beauv. ex Roem. & Schult.		Herb	GS	LWG 260225	Plant is used as fodder.
Koeleria cristata Auct.		Herb	GS	LWG 260219	Plant is used as fodder.
Muhlenbergia himalayensis Hack. ex Hook.f.		Herb	GS	LWG 260212	Plant is used as fodder.
Ophiopogon intermedius D. Don		Herb	GS	LWG 260237	Plant is used as fodder.
Oplismenus burmannii (Retz.) P. Beauv.		Herb	GS	LWG 260241	Plant is used as fodder.
Phragmites communis Trin.		Herb	GS	LWG 260226	Plant is used as fodder.
Poa annua L.		Herb	GS	LWG 260235	Plant is used as fodder.
Pogonatherum paniceum (Lam.) Hack.		Herb	GS	LWG 260221	Plant is used as fodder.

Continued

Table 1. *Continued.*

Family & Species	Vernacular Name	Habit	Habitat	Voucher No.	Ethnobotanical notes
Themeda arundinacea Ridley.		Herb	GS	LWG 260211	Plant is used as fodder.
Tripogon filiformis Nees ex Steud.		Herb	GS	LWG 260212	Plant is used as fodder.
Polygonaceae					
Rumex hastatus D. Don.	Amilda, Amildu	Herb	RS, HH	LWG 261032	Paste of leaves is applied on cuts and wounds to check bleeding. Leaves are edible.
Rumex nepalensis Spreng.	Kholiya, Kashmiri Palak	Herb	RS, HH	LWG 261045	Juice from the crushed leaves relieves irritation of sting nettle. Leaves are used in stomach problems and also as vegetable.
Primulaceae					
Primula denticulata Sm.	Saumya	Herb	DF, RS	LWG 261023	Leaves are used to make poison.
Ranunculaceae					
Aquilegia pubiflora Wall. ex Royle	-	Herb	DF, RS	LWG 261078	-
Clematis montana Buch.-Ham. ex DC.	-	Climber	RS	LWG 261054	-
Rosaceae					
Cotoneaster bacillaris Wall. ex Lindl.	Ruins	Shrub	RS	LWG 261083	-
Cotoneaster microphyllus Wall. ex Lindl.	Jhinjhro	Shrub	RS, DF	LWG 261082	Stolons are used as an astringent.
Duchesnea indica (Jacks) Focke	-	Herb	RS	LWG 261021	Ripe fruits are edible and used in stomach problems. Leaf juice is given in diarrhoea and leukorrhea.
Fragaria nubicola (Hook. f.) Lindl. ex Lacaita	-	Herb	RS	LWG 261055	Leaves are useful in diarrhoea and treatment of urinary organs. The fruit is astringent and diuretic.
Rosa moschata Mill.	Kujju	Climber	RS	LWG 261092	-
Rubus ellipticus Sm.	Hinsar	Shrub	RS	LWG 261036	Roots are fermented to make local vine while fruits are edible.
Rubus foliolosus D.Don.	-	Shrub	RS	LWG 261097	-
Rubus macilentus Cambess.	-	Shrub	RS	LWG 261054	-
Rubus niveus Thunb.	Kali Hinsar	Shrub	RS	LWG 261090	-
Potentilla sundaica (Blume) Kuntze	-	Herb	RS	LWG 261088	-
Prinsepia utilis Royle	Bhekal	Shrub	RS	LWG 261039	Oil from the seeds is used in rheumatism and to relieve pains from over-fatigue.
Prunus persica (L.) Batsch	Aadu	Tree	HH	LWG 261028	Tree produces edible fruits called peach.
Pyrus pashia Buch.-Ham. ex D. Don	Bhamoor, Mol	Tree	HH	LWG 261038	Fruits are edible (Wild Himalayan Pear). Wood is used to make implements.
Salicaceae					
Populus nigra L.	-	Tree	RS, HH	LWG 260209	-
Salix denticulata Andersson	Ootis, Gandriyos	Tree	RS	LWG 261066	-
Sapindaceae					
Aesculus indica (Wall. ex Camb.) Hook.	Pangar	Tree	RS, HH	LWG 261077	Seed oil is used in rheumatism while leaves are used as a fodder and manure.
Saxifragaceae					
Bergenia ciliata (Haw.) Sternb.	Patharchur	Herb	DF, ROMF, RS.	LWG 261025	Rhizome of plant is used for kidney stones. A decoction of rhizome is also used in fever and stomach problems.
Smilacaceae					
Smilax aspera L.		Climber	ROMF	LWG 260217	
Smilax elegans Wall. ex Kunth	Kaplagla	Climber	RS	LWG 260206	-
Smilax spinosa Mill.		Climber	ROMF	LWG 260213	
Thymelaceae					
Daphne papyracea Wall. ex G. Don	Satpura	Shrub	DF, ROMF	LWG 261016	Stem is used to make ropes.
Valerianaceae					
Valeriana jatamansi Jones	Jatamansi	Herb	DF	LWG 261013	Plant is used to treat diseases of eye, blood, liver and also to treat hypochondriasis and nervous unrest.
Violaceae					
Viola canescens Wall.	Gulbanfsha	Herb	RS	LWG 261006	Flowers are used for curing fever, cold, bronchitis and asthma.
Zingiberaceae					
Hedychium coronarium J. Koenig	Herb	Herb	ROMF	LWG 260238	

Arundinella, *Berberis*, *Geranium*, *Gentiana*, *Plantago*, *Quercus* and *Rumex* were represented by two species each. Herbs were the most dominant growth form in the region. The percentage of different growth forms recorded in study area is shown in Figure 3.

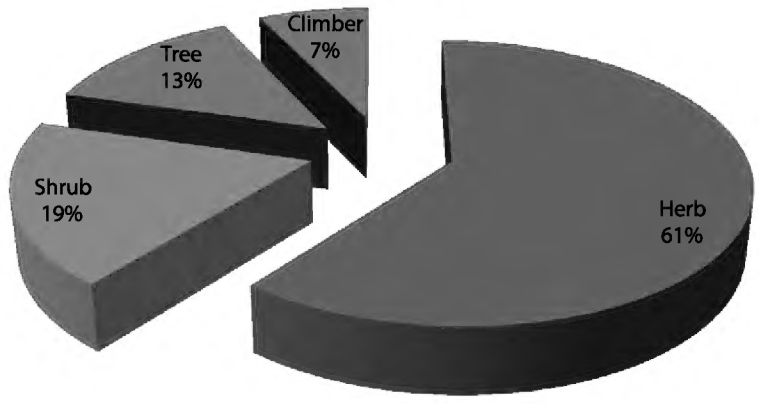

Figure 3. The percentage of different growth forms recorded in Dhanaulti region, Uttarakhand.

Threatened taxa

Bergenia ciliata (Haw.) Sternb and *Valeriana jatamansi* Jones were also recorded from the region, which are listed as vulnerable under various threat categories as per Ved et al. (2003).

Ethnobotanical use

A total of 25 people, including 12 men and 13 women, were interviewed to gather ethnobotanical information about the wild plants. A total of 51 plants have been found to have ethnobotanical usage in the study area. Of these, the majority were reported to be used for fodder (41%). The percentage of plant species utilized in various ways by the locals is given in Figure 4.

The plants *Aesculus indica* (Wall. ex Cambess.) Hook. (Pangar), *Valeriana jatamansi* Jones (Jatamansi), *Oxalis corniculata* L. (Khattimeethi), *Quercus floribunda* Lindl. ex A. Camus (Moru oak), *Quercus leucotrichophora* A. Camus (Ban oak), and *Taraxacum officinale* (L.) Weber ex F.H.Wigg. (Dhudhiya) were recorded as multipurpose species. The most widely used plant part was leaf followed by stem and the least were seeds and bark (Figure 5).

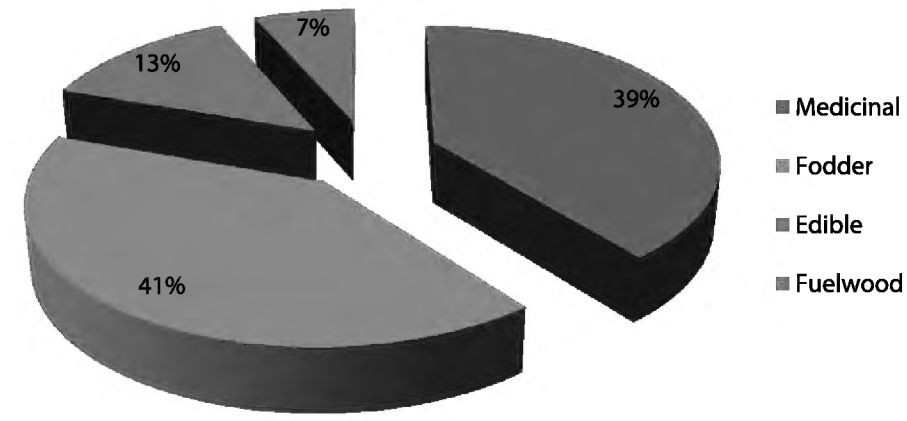

Figure 4. Percentage of plant species utilized in various ways by the locals in Dhanaulti region, Uttarakhand.

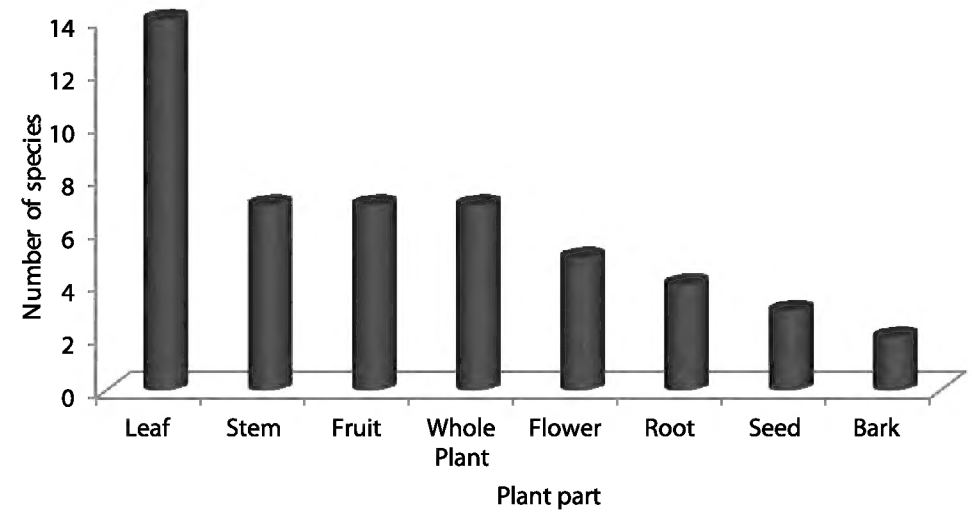

Figure 5. Usage of plants with respect to plant part used in Dhanaulti region, Uttarakhand.

DISCUSSION

Of the total angiospermic plants recorded in the Dhanaulti region, the species richness was observed to be highest along the road-side (55 species) followed by Rhododendron-Oak mixed forests (22) and grassland (21). Due to the dense canopy in Deodar forests, very few plant species were found to be in flowering or fruiting and hence, were comparatively less rich. The floristic diversity in mixed forests of Oak and Deodar was richer as compared to pure stands of Oak and Deodar. *Rumex nepalensis* Spreng., *Malva parviflora* L., *Sonchus oleraceus* (L.) L., *Capsella bursa-pastoris* (L.) Medik. and *Brassica juncea* (L.) Czern. were found growing exclusively near human habitations which could be due to nitrogen enrichment of soil by livestock dung.

The plant species richness in Dhanaulti block was found higher in mixed forests comprising of Oak and Deodar species as compared to pure stands of Deodar and Chirpine. The participatory conservation approach of Dhanaulti Ecology and Ecotourism Development Committee of planting more than 1,000 saplings of Deodar tree species as memory plantations in the eco-park area has improved the environmental conditions of the Dhanaulti region. Besides, the committee also looks after the conservation and management of adjoining forest areas (Kiss 2004).

In Himalaya, tourist destinations are prone to ecological degradation due to influx of large volume of tourists and associated developmental activities. Thus, at a time when tourism is in its nascent stage, it becomes imperative to prepare a baseline of natural wealth of the area for future monitoring and conservation purposes. The present inventory is expected to provide baseline scientific data, which can be used by forest managers, area developers and researchers for further studies. In order to enhance the tourism activities in a considerate way towards nature, the information will be helpful in understanding the floral diversity and landscape management of the region as well as of the eco-parks.

Figure 6. (**A**) A view of Dhanaulti Eco-Park, (**B**) Deodar forest near *Aloo-khet,* Dhanaulti, (**C**) Mixed forest of Oak, Rhododendron and Deodar and (**D**) Pure stand of Deodar (2,415 m) in Dhanaulti region, Uttarakhand. Photos: Mansa Srivastav.

Figure 7. (**A**) *Aesculus indica,* (**B**) *Hypericum oblongifolium,* (**C**) *Ainsliaea latifolia,* (**D**) *Viola canescens,* (**E**) *Primula denticulata* and (**F**) *Prunus persica* in Dhanaulti region, Uttarakhand. Photos: Mansa Srivastav.

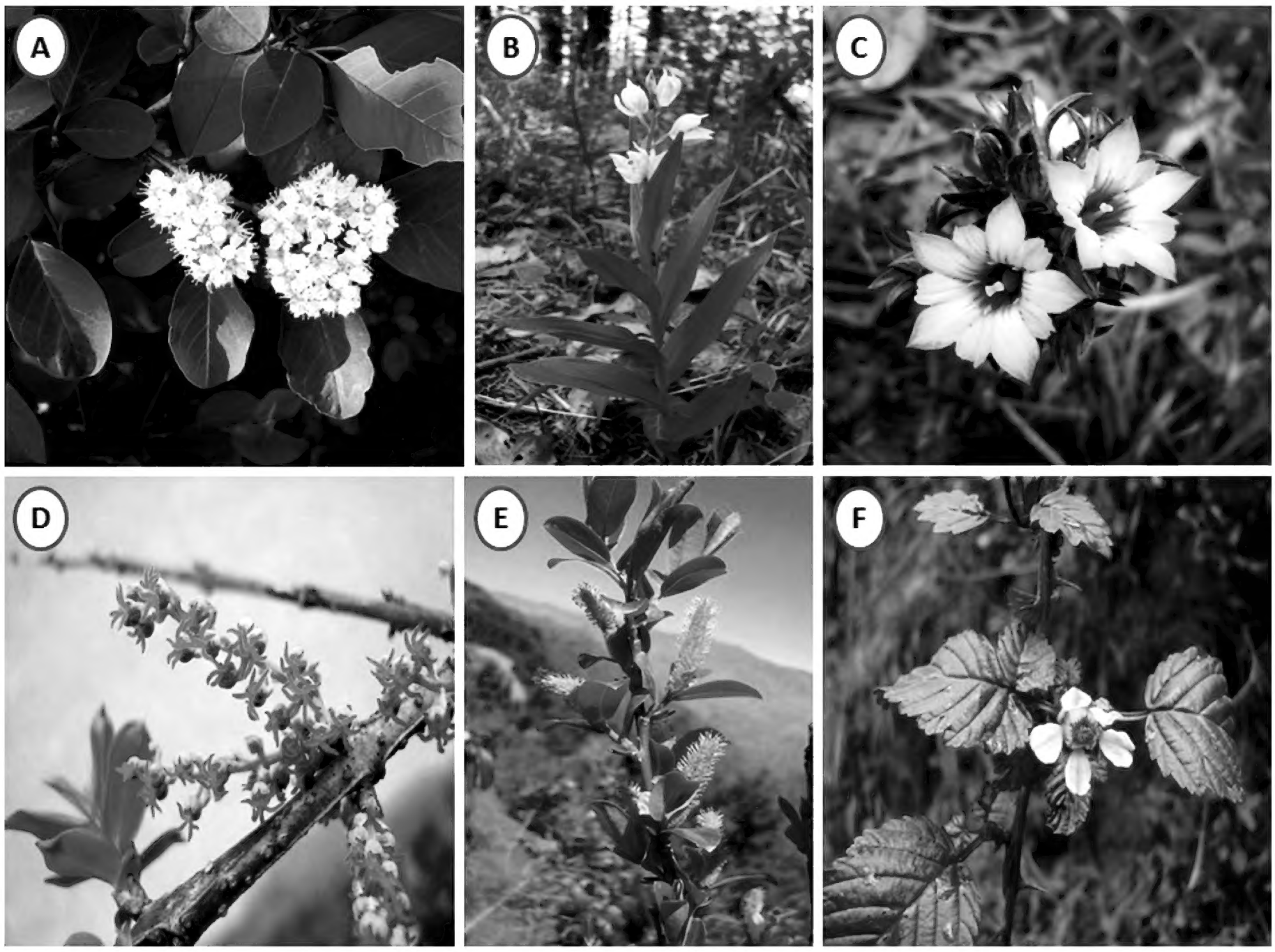

Figure 8. (**A**) *Cotoneaster bacillaris,* (**B**) *Cephalanthera longifolia,* (**C**) *Gentiana argentea,* (**D**) *Coriaria nepalensis,* (**E**) *Salix elegans* and (**F**) *Rubus macilentus* in Dhanaulti region, Uttarakhand. Photos: Mansa Srivastav.

Figure 9. Threatened plants (**A**) *Bergenia ciliata* and (**B**) *Valeriana jatamansi* in Dhanaulti region, Uttarakhand. Photos: Mansa Srivastav.

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